CHAPTER 7

DOORS, WINDOWS, AND BUILDERS' HARDWARE

SECTION I—MAINTENANCE AND REPAIR OF DOORS

7.1.1 General

Exterior doors are more subject to abuse and weathering than interior doors, but, in general, defects and corrective measures are similar.

7.1.2 Periodic Inspection

Doors should be inspected quarterly for poor fitting, including loose or broken battens; deteriorated or damaged frames; paint deterioration; material damage; cracked or broken glass; split or cracked wood panels; warped or dented metal; warped or broken screening; broken or inoperative hardware (locks, hinges, and sliders).

7.1.3 Wood Doors

7.1.4 Butt-Hinged Doors

Mechanical injury to mullions, headers, jambs, or hardware usually causes trouble with large wood-batten framed and braced doors. Decay, resulting from exposure to weather or shrinkage of door members, also causes distortion or failure. Frequently, the free edge of the door sags and causes the door to bind at the bottom and open at the top.

7.1.4.1 *Checklist for Repair*

Effective remedies may be determined by first checking the following:

a. Examine the jamb opening to see that the hinge and lock sides are plumb and parallel.

b. Check the doorhead to see that it is level.

c. Check anchorage of the jamb.

d. Check anchorage of hinges.

e. Check lock faceplates for projection beyond the face of the door.

f. Check all members for swelling, shrinking, or warping.

7.1.4.2 *Repairs.* The following procedures apply when the door itself has shrunk or is warped, swollen, or sagged.

a. When a door shrinks, remove the hinge leaves and install a filler (cardboard or metal shim) at the outer edge of the jamb and hinge mortice. This forces the door closer to the jamb at the lock edge. If the hinge pins do not bind, the door will operate satisfactorily. Each hinge should be shimmed equally to prevent the door from becoming hinge bound. When the door has swelled, place shims in the inner edge of the hinge mortice as shown in figure 7-1.

b. Restore a warped door to its normal shape by removing it and laying it flat. Weighting it down may also be necessary. If it is still warped after a reasonable length of time, battens screwed to the door help restore it to true plane. Screw eyes, rods, and turnbuckles help straighten a door by gradually pulling it into place.

c. Install a diagonal batten brace from the top of the lock side to the bottom of the hinge side to repair a sagging door permanently. The diagonal brace must cover the joint between rail and stile and be securely fastened to both members, at top and bottom, and other intermediate rail members. Temporary repair is made by installation of a wire stay brace equipped with turnbuckles and placed diagonally in the reverse direction from a batten brace.

d. Doors or door members may require rebuilding because of neglect or abuse. Remove the door to a flat surface and replace the damaged member. Carpenter's clamps assist in holding door members square while nails or screws are driven.

e. Trim the door when the preceding methods fail to correct the trouble. However, do not cut doors immediately following rain or damp weather. When dry, the door may fit too loosely.

7.1.5 Wood Panel Doors

Failures in panel doors are similar to those in large wood doors. In addition, doors are subject to binding at the hinge edge, friction between the dead bolt and strike plate, or between the latch-bolt and strike plate.

7.1.5.1 *Locking.* Trouble with the locking apparatus is generally caused by defective knobs or locks. Check the knob to determine whether the spindle is worn or only loose. Where a lock does not move

smoothly, replacement may be necessary, although repair of worn parts or lubricating with graphite frequently overcomes the difficulty.

7.1.5.2 *Rattling.* An excess of space between the door and stop head causes the door to rattle. Removal and refitting of the head stop while the door is closed remedies this difficulty. The door may also rattle because of too much play between the latchbolt and strike plate. Correct this condition by moving the plate back toward the stop.

7.1.5.3. *Loose Hinges.* Hinges become loosened if a door is *too* tight on the hinge edge and binds against the hinge jamb. If the door has plenty of clearance on the lock side and the entire pin seems to move slightly when the door is closed, loosen both hinges at the frame and insert card-board under the jamb leaves along the outer edges. To make a uniform space between the jamb and the door, insert a strip of cardboard under the inner edge of the top hinges in the leaf which is fastened to the jamb. This usually corrects the trouble by pulling the upper part of the door closer to the jamb. However, considerable space above the door and along the outside (lock edge) may result. In that case, loosen the screws in the leaf of the bottom hinge, which is attached to the jamb, and insert cardboard under the other edge. If the hinge has been pulled loose and the wood screws have damaged the wood fibers on either the door or jamb, the holes may be plugged with wood plugs or filled with plastic wood.

7.1.5.4. *Warping.* A warped door that has spring inward or outward at the hinge edge is impossible to close without considerable pressure against the bulging part. This trouble is generally overcome by placing an additional hinge midway between the other two to hold the door straight. If another hinge cannot be obtained, temporary repair is made by shifting the hinges outward or inward on the jamb, as shown in figure 7-1. Adjust stops according to the position of door when closed and latched.

7.1.5.5 *Settling and Shrinkage.* Settling of the foundation or shrinkage and deflection of framing members often causes trouble at door openings. When the greatest settlement is on the hinge side of a door, the door will tend to become floor-bound at the lock side. When settlement is greatest on the lock side, the door will bind at the head jamb. As a result, the bolt in the lock will not be in alignment with the strike plate, making it impossible to lock the door securely. Vertical settlement and horizontal deflection will cause the jamb openmg to become out of square. On most wood doors, the simple correction is to plane as required at either the top or bottom rail for proper clearance. Another method, more complicated but producing better results, is to lift off the strike plate and nail or screw a wood strip extending up and down the entire length of the door frame, as shown in figure 7-2. It is necessary to cut a hole in this strip for the latchbolt. An alternate method is to remove the hinges from the door and screw a wood strip to the door, extending the entire length. Countersink all nails or screws, and place putty over all holes.

7.1.5.6. *Latching.* When the latch does not operate because of poor alignment with the strike plate (figure 7-3), enlarge the hole in the strike plate by filing. If the bolt strikes squarely on the plate and requires removal of as much as **c** inch of metal, remove the strike plate and raise or lower it as necessary.

7.1.5.7 *Uneven Side Margins.* It is seldom necessary to plane a door if trouble is caused by loose or improperly morticed hinges. However, if planing is necessary because side margins are uneven and the door strikes at top or bottom because of settlement of the frame or similar causes, locate the points of friction. It is easier and less noticeable to plane the hinge edge. Bevel the lock edge of the door about **c** inch to facilitate closing. If the door still strikes along the lock edge, plane the hinge edge and cut in the hinge leaves flush with the surface, if necessary.

7.1.5.8 *Sticking* Damp weather often causes a door to stick. Absorption of moisture results in swelling of the framework and door. If the door has an even margin along the top and bottom edges and if the hinges are firm, the hinge edge must be planed. It is best to plane the hinge edge because hinges are more easily removed and remorticed than the lock. Take care not to plane off too much wood. When it is necessary to trim a door for better fitting, carefully mark the amount to be planed, allowing clearance on all sides of approximately the thickness of a dime. To determine the correct amount of wood to be removed, set the door hard against the hinge side, wedge it plumb, and scribe the desired thickness of material to be planed off. When planing or cutting is completed, repaint the edges before rehanging the door.

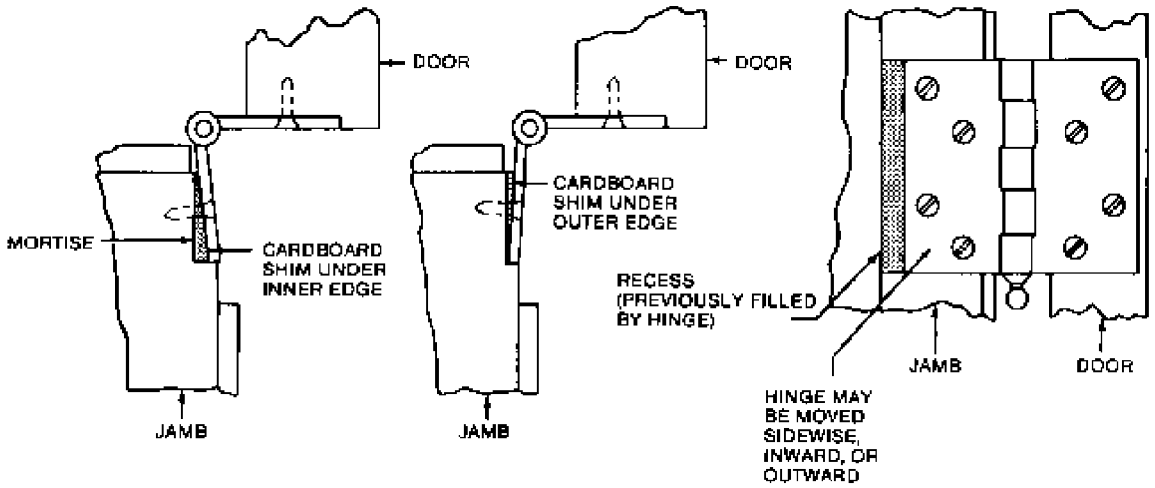


Figure 7-1. HINGE ADJUSTMENT FOR BINDING OR STICKING DOORS.

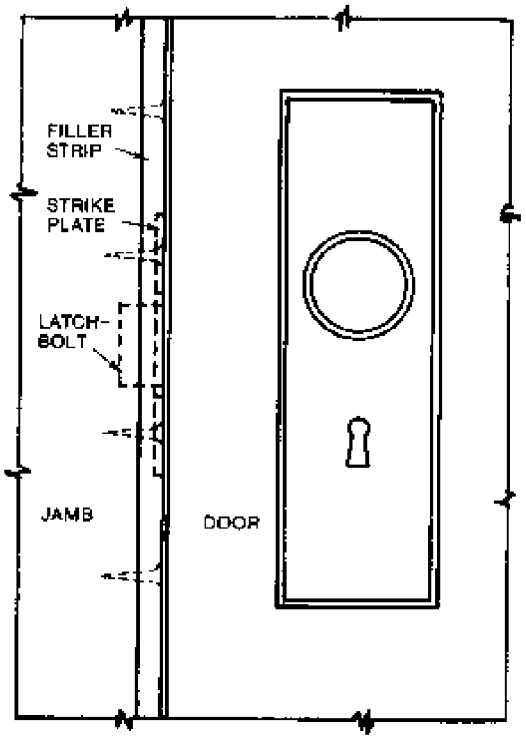


Figure 7-2. VIEW OF DOOR JAMB SHOWING FILLER STRIP.

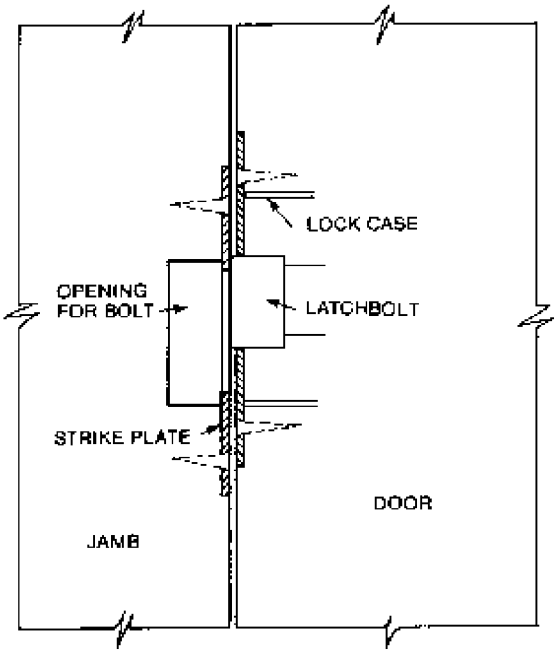


Figure 7–3. POOR ALIGNMENT OF LATCHBOLT WITH STRIKER PLATE.

7.1.5.9 *Bevel.* Proper bevel for wood doors of 2 feet 8 inches to *3* feet in width is about $^{1}/_{16}$ inch per 1 inch of door thickness. On doors of smaller width that are of equal thickness, the bevel should be increased proportionately to the decreased width of door. On wider doors, the bevel can be decreased proportionately to the increase in width of the door. See figure 7-4.

7.1.6 Metal Doors

7.1.6.1 *Types.* Metal doors, commonly used in warehouses, hangars, stockrooms, mess halls (galleys) and other areas where hard service or industrial operations require them, are of various types: metal, clad, hollow metal, and solid metal, with variations including interchangeable glass and screen panels.

7.1.6.2 *General Maintenance.* Because most metal doors and fittings are shop designed and fabricated, it can be assumed that they will maintain their shape and mechanical operating abilities provided hinges, locks, and other fittings remain secure in their fastenings. This is accomplished by checking screens, nuts and bolts, and special fasteners and operating devices regularly and keeping them tight and in good order. Building settlement, mechancial failure, and collision may require investigation and corrective measures for a basic cause of misalignment in the structure framing itself. Frames must be plumb and corners square so that the door fits its opening with proper clearances. Weatherproofing and caulking must be maintained in a workmanlike manner. Mechanically operated doors must be removed and straightened, repaired, or replaced. Repair material and finishing should match the existing material. Shop repair of metal doors should meet acceptable standards for welding, riveting, and sightliness. Replacement of surface metal on fireproof, metal-clad wood doors must be weathertight and of material of the same gage as originally provided. Service doors in mess halls (galleys), stockrooms, and other areas where personnel pass in and out frequently with arms loaded should be provided with kick plates and with bumper protection to prevent slamming against walls.

7.1.7 Fire Doors

Fire doors are specifically designed and installed to restrict the spread of fire and smoke in facilities. They are usually of metal, metal clad, or wood construction with or without lights as described below and are classified in accordance with NFPA Standard 252 or other approving authorities.

7.1.7.1 *Types of Doors.* The most common types of doors, as described in NFPA Standard 80, "Fire Doors and Windows," are composite doors of wood, steel or plasic bonded to a solid core; hollow metal doors; metal-clad doors of metal over wood cores; sheet metal doors; rolling steel doors;

curtain-type doors; and wood core doors of wood or plastic bonded to wood core. Doors with lesser fire protection spread ratings may include wired glass lights.

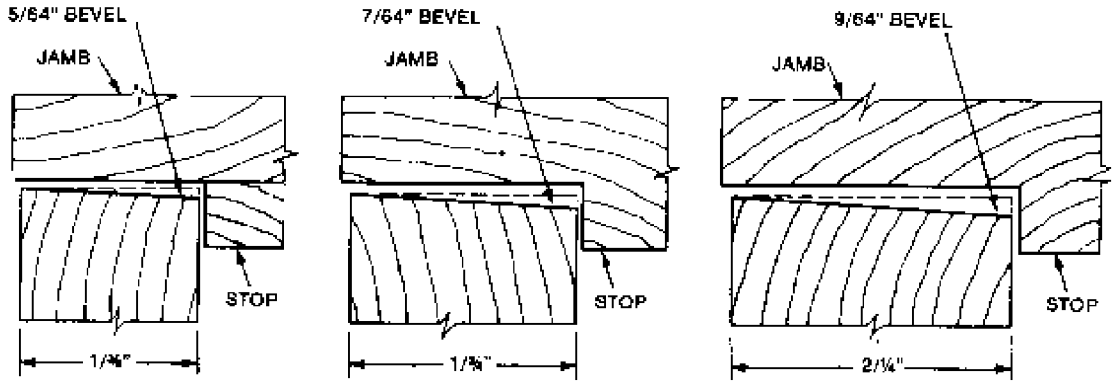


Figure 7-4. DOOR BEVEL FOR NORMAL WIDTH OPENINGS.

7.1.7.2 *Inspections.* Doors must be kept operable at all times and should be kept closed. Maintenance includes frequent inspection of hinges, catches, closers, latches and stay rolls. Lights, if any, and door face coverings, chains or cables, should also be inspected. In addition, metal- and tin-clad doors should be inspected for dry rot. Areas surrounding doors should be inspected for blockage and doors inspected for tampering such as wedges to keep the door open or devices which inhibit their opening.

7.1.7.3 *Maintenance.* NFPA Standard 80 and the manufacturer's recommended maintenance should be followed. Lubricate guides and bearings and adjust chains and cables on counterbalanced doors as needed to insure proper operation. Replace worn hardware immediately. Broken light panels should be replaced with at least ¼-inch-thick wire glass. Faults in face coverings should be immediately repaired as described in paragraph 7.1.5.2.

7.1.8 Hangar and Warehouse Doors

Doors used in hangars and warehouses are commonly of the rolling type and motorized; they impose extreme loads on the narrow bearing surface of supporting rails. They require specialized maintenance in accordance with the manufacturer's recommendations. If major warping or displacement of sliding panels occurs, engineering personnel should be consulted on repair. Settling or failure of roof trussing can cause displacement of overhead rails and guides, imposing stresses on the panels. Maintenance of large metal areas of doors is similar to that for metal sidings, as recommended in chapter 4. Complicated devices for operating large doors should be maintained according to the manufacturer's recommendations.

7.1.8.1 *Minor and Routine Maintenance.*

a. Keep rails, guides, springs, and rollers secure and free from dust, dirt, corrosion, and obstruction.

b. Keep upper rails and rollers lubricated according to the manufacturer's recommendations.

c. Check and maintain alignment of rollers and rails.

d. Check guides for security and alignment. Straighten bent guides.

e. Repair damaged glazed sections promptly.

f. Inspect and lubricate motors as recommended by manufacturer.

g. Keep hinges and springs free from dirt, debris, and corrosion, and lubricate them regularly. Replace sprung or broken hinges and springs and other door fittings.

h. Keep locks and latches lubricated and in good repair.

7.1.8.2 *Adjustment to Hangar Door Guides.* The methods used in adjusting door guides depend on the type of door mechanisms involved. The detailed procedures explained herein are for a particular type of construction. However, the principles applied in the adjustment of this door can be used on many types of door and truss configurations. The causes of binding of sliding hangar doors in timber truss-type hangars are discussed in paragraph 3.4.9.3.

a. Considerable difficulty has been encountered in hangars containing Pratt trusses with a span of

120 feet. Usually the trusses over the doors carry considerable additional loads, for the door canopy and guides are cantilevered out beyond those trusses. The 120-foot trusses are usually erected with a 4- to 6-inch camber, and the door guides are adjusted for a fixed distance from the deck. The distance between truss chords and door guides will, therefore, vary, the greatest differences being at the center of the span.

b. A practical means for adjusting the door guides is to raise the outriggers at their point of contact with the bottom chord of the door trusses. This is accomplished by driving oak wedges between the outriggers and chords. Before raising the outrigger, it will be necessary to notch the sills supporting the bulkhead; otherwise, the entire bulkhead will be raised with the outrigger. It may be necessary to raise the canopy to relieve the strain when driving the wedges. One jacking tower, made up of 6 x 64nch timbers, and suitable cross bracing, should be constructed for this purpose. By setting the tower under each outrigger, in turn, and jacking it to its predetermined height, the wedges can be installed and the jack removed. All bolts connecting the outrigger to both trusses should be loosened while performing this operation.

c. In some hangars, the arrangement of outriggers and door guides is somewhat different. These guides are bolted to the underside of the outriggers, with a spacer timber between the flange of the "T" guide and the underside of the outrigger. The guides can be adjusted in this case by removing the space timber, and, in its place, installing a correct number of shims or blocks to bring the guides to the proper grades. Where corrections are made in this manner, it will be possible to readjust the guides at a later date, if necessary, by removing some of the shims. The only equipment required for this work, other than the usual mechanic's tools, will be a portable scaffold of sufficient height to reach the canopy.

d. When making adjustments to the doors, the wheel adjustment should be taken up as much as possible and the wheels well greased. Check the rails and chip away any concrete rubbing against the flange of the wheels. The door rails should be kept clean at all times. It is recommended that the operation forces be instructed to sweep out the tracks daily. Exercise extreme caution when adjusting door guides, for the guides have only a few inches bearing on the door at the top; and, if the guides are raised too much, the doors will tumble over, probably with disastrous results. Adjustments to door guides should not be made by cutting material from the stem of the "T" rails, as this only reduces the bearing surface of the guides.

7.1.9 Cold-Storage Doors

Doors in cold-storage rooms, including meat track doors, should be checked for tight closing. Latches should be adjusted if necessary. Hinges and latch mechanisms should be lubricated regularly. Gaskets should be cleaned and checked for necessary replacement. Special attention should be given to low-temperature installations, where nonfreezetype (electrical resistant) gaskets are used. Doors should be inspected for damage or deterioration, and bumper guards checked. Ceilings and walls should also be inspected for loose insulation, cracks, or other defects in wood, cement, or mastic finishes. Wall and corner guards should be checked for condition. Meat tracks should be secure. To reduce deterioration, tracks should be cleaned and repainted as necessary.

7.1.10 Detention Doors

Detention doors should be inspected regularly for security of locking devices. Breakout alarms attached to door locks should be checked for operational readiness. Electrical or pneumatic controls for simultaneous locking and unlocking of doors in large, cell-block installations should be checked by qualified personnel. Locking devices and hinges should be lubricated regularly.

7.1.11 Storm Doors

Storm doors are commonly made of wood or aluminum, with appropriate glazing. Wood storm doors should be maintained and repaired according to the manufacturer's recommendations.

7.1.12 Screen Doors

Screen doors, usually made with wood or aluminum frames, should be fitted with wire guards and wood or metal push bars on the inside to avoid pressure on the screening in opening them. Doors should be sized or trimmed to allow proper clearance at the head, jambs, and bottom. Too much clearance will defeat the purpose of excluding insects, but doors should not stick or bind, which causes damage to the frames under traffic. A sagging screen door can be straightened by the use of a metal rod with a tumbuckle. One end of the rod is fastened to the face of the frame, at the center of the intersection of the bottom rail and the outer vertical rail. The other end is fastened as high on the face of the hinge rail as it will reach. The tumbuckle is then turned to shorten the rod and thus lift the bottom rail. Doorframes are maintained as recommended in paragraph 7.1.3. Screen maintenance should conform to recommendations in paragraph 7.2.8.

SECTION II—MAINTENANCE AND REPAIR OF WINDOWS

7.2.1. Periodic Inspection

Windows should be inspected for loose-fitting or damaged frames, ilifitting or broken sashes, cracked or broken glass, deteriorated putty, broken or worn sash cords, and missing or broken hardware. If atmospheric conditions cause ordinary putty to crumble quickly, plastic glazing compound should be substituted. Leaks may be caused by material shrinkage. Frames and cover molds of wood windows should be inspected, along with sills, jambs, and heads of metal windows. Open joints should be caulked. A slight shrinkage of putty away from the glass can often be corrected by needle glazing with a soft plastic compound. Rust spots on metal sashes and frames should be wire-brushed or sandpapered, cleaned with a rag saturated with mineral spirits, and then spot-painted.

7.2.1.1 *Types of Windows.* The following discussion is extracted from *Building Construction, Materials and Types of Construction* by Whitney Clark Huntington and Robert E. Mickadet, courtesy of John Wiley and Sons, New York. The usual types of windows, regardless of materials in their construction, are illustrated in figure 7-5. The glass areas in these examples are subdivided in various ways which may have no significance to the type of window illustrated. Some windows may include only a single pane of glass. Subdivisions may be made to permit the inclusion of ventilating units, for convenience in cleaning, to limit glass size for safety, for architectural effect, or for other reasons. Various types of windows or sashes are often combined as a single window opening.

7.2.1.2 A fixed window (figure 7-5(A)) makes no provision for natural ventilation.

7.2.1.3 For double-hung window (figure 7-5(B)), both sashes slide vertically, with the weight of each counterbalanced by sash weights, spiral spring balances, or tape spring balances similar to clock springs. The sash is easily operated dnd edge friction will hold it in any set position. For a single-hung window, only the lower sash operates. Some types are arranged so that the sash can be removed from the inside.

7.2.1.4 One or both sashes for a horizontal-sliding window (figure 7-5(C)) may be arranged to slide. Some types are also arranged so that the sash may be removed from the inside. Heavy sashes are often provided with nylon rollers for ease in operation. Sashes are sometimes suspended from rollers operating on overhead tracks.

7.2.1.5 In general, any hinged window is a casement window. It may swing out or in and may be hinged at either side, the top, or the bottom but the term is usually applied only to side-hinged windows. An outswinging casement window with two sashes is shown in figure 7-5(D). Each sash swings on extension hinges attached to the hanging stile of the sash and the jamb of the frame. The extension provides an open space between the hanging stile and the jamb to facilitate cleaning the outside. For an inswinging casement window (figure 7-5(E)), extension hinges are used to make the sash swing clear of the inside surface of the wall. One or more casements of either type may be included in a single opening. For example, three sashes could be included by providing a mullion between a single sash and a pair of sashes. Outswinging casements are more widely used than inswinging. The folding window (figure 7-5(F)) is a form of outswinging casement window with the two sashes hinged together on their meeting stiles rather than each to its outside stile. Projection arms are arranged so that the sash operate symmetrically.

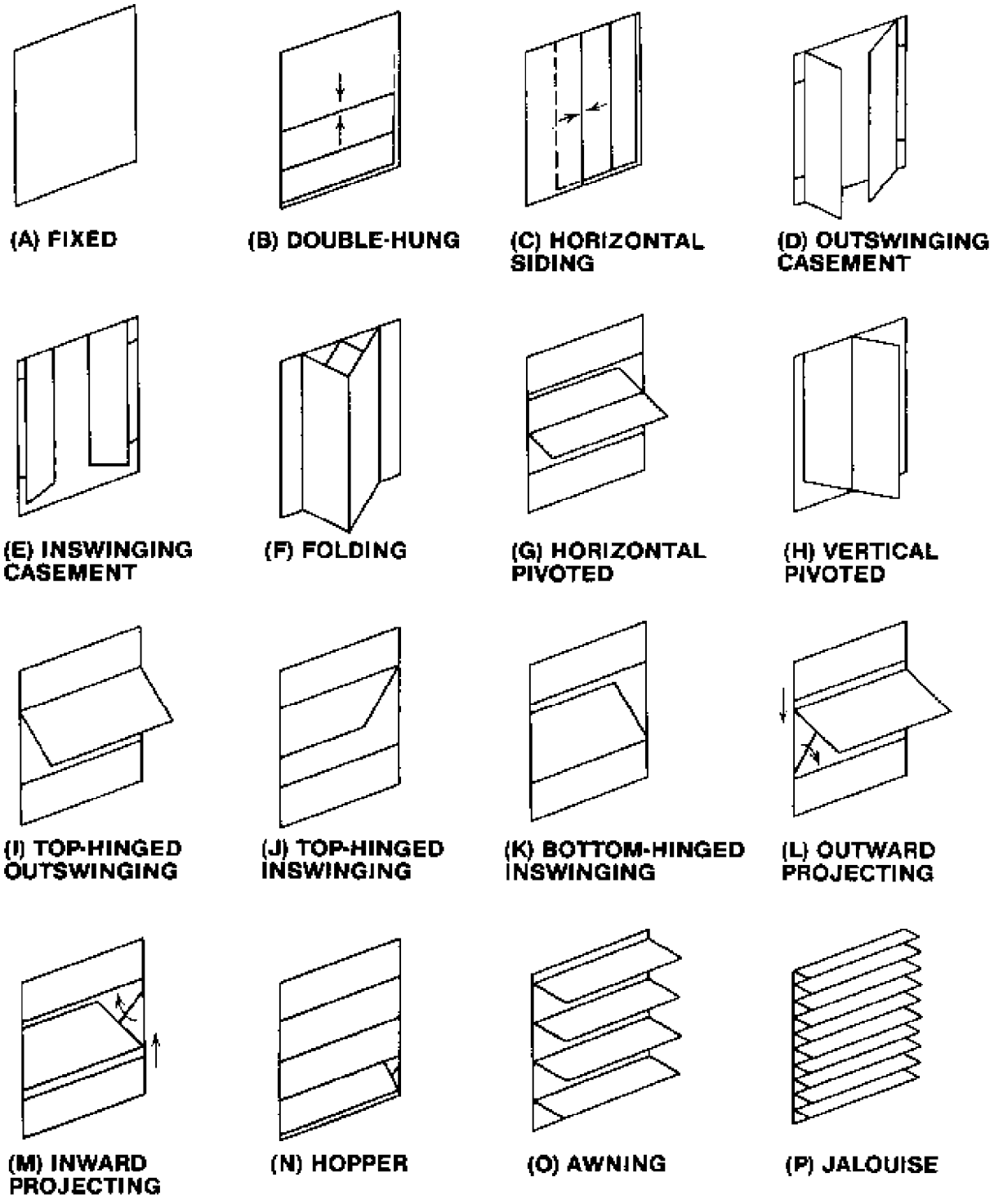


FIGURE COURTESY OF JOHN WILEY & SONS, INC.
FROM BUILDING CONSTRUCTION BY
WHITNEY CLARK HUNTINGTON AND ROBERT E. MICKADET

Figure 7-5. WINDOW TYPES—OUTSIDE VIEWS FOR OPEN POSITIONS.

7.2.1.6 A horizontal-pivoted sash (figure 7-5(G)) is pivoted at the center. Such sashes are often arranged in a row to form a continuous or ribbon window located in a sawtooth roof or monitor and are operated in unison from the floor by a mechanical operator.

7.2.1.7 A vertical-pivoted sash (figure 7-5(G)) is often arranged to swing in a full circle.

7.2.1.8 Sashes may be top-hinged and outswinging, top-hinged and inswinging, or bottom-hinged and inswinging (figure 7-4 (I), (J), and (K)).

7.2.1.9 Projected windows have ventilation sashes which operate like the outward-projecting window shown in figure 7-5(L). The ends of the arms are pivoted to the stile of the sash and to the frame. Shoes are attached to the top rail of the sash and move vertically along the stiles, guided by tracks attached to the vertical members at the sides of the opening. An inward-projecting window is shown in figure 7-5(M). If the latter is located at or near the bottom of a window, it is called a hopper ventilator (figure 7-5(N)). If several outward-projecting ventilators are located vertically adjacent to each other and are arranged to be operated simultaneously by a single operator, the window is called an awning window (figure 7-5(0)). Fixed meeting rails sometimes are provided between adjacent sashes. The downward movement of the top rail of the projected sash provides an opening through which the outside of the outward-projecting sash can be cleaned.

7.2.1.10 A jalousie window (figure 7-5(P)) is similar to an awning window except the ventilating units are heavy glass slats from 3 to 8 inches wide with metal end supports to which the operator is attached. Adjacent edges of the slats overlap ½ inch or more to exclude rain and reduce air infiltration. There is considerable air leakage when closed, and they are usually used only for enclosed porches or where air leakage is not objectionable.

7.2.2 Wood Windows

7.2.2.1 *Causes of Failure.* Window failures may result from various causes, the most common being weathering. Weathering causes loss of putty and paint with subsequent deterioration and rotting of wood members; binding of parting or stop heads; windows forced out of shape by settling, shrinking, or twisting of the building frame; swollen or improperly fitted sashes; broken or uneven sash cords; and sashes stuck from paint in the pulley stile.

7.2.2.2 *Binding.* When it is determined that the sash in a double-hung window binds because of pressure against the parting bead, thorough waxing of parts in contact prevents much unnecessary labor. Binding of horizontal sliding sashes is also relieved by this procedure. When the insidE stop beads of a double-hung window press toc tightly against the sash, reduce the thickness of beads by planing, sanding, or scraping along thE edge adjacent to the sash, or move the beads farther from the sash. Carefully plane the top or bottom rail to relieve binding in horizontal-sliding sashes. After planing, coat the sash with linseed oil and wash it when the oil has dried.

7.2.2.3 *Settlement.* Careful nailing frequently restores the shape of frames that are forced out of shape by settling, shrinking, or twisting of the building. Cutting the sash is not recommended as a remedy.

7.2.2.4 *Swelling.* Do not cut any window that will resume its original size when properly dry. Cut or plane a sash or frame that is swollen by moisture only when it is determined that the member is too large, even when dry. Remove and plane a sash when the vertical edge binds against the pulley stile or running face of the window frame. To locate high spots on the sash, rub the sash stile with chalk and then slide the sash from closed to open position two or three times. High spots on the sash are indicated at points where the chalk has rubbed off.

7.2.2.5 *Bowing.* Occasionally a parting bead becomes too long, causing a bow in the middle. In this case, remove the bead from the frame and cut **c** to ¼ inch from one end.

7.2.2.6 *Broken Cords.* Broken or missing cords call for careful removal of the stop bead. Remove the lower sash from the frame. Knot the cords to prevent them from running through the pulley after the window is detached. Remove the parting bead to remove the upper sash. Install new cord, then replace the upper sash, parting bead, lower sash, and stop bead, in that order. An economical and efficient substitute for a broken cord or pulley is the sash control spring. This spring can also be used in lieu of barrel bolts and other devices for the control of a nonbalanced sash. Proper sash operation requires that the combined clearance of the two edges be **c** to $^{3}/_{16}$ inch. When installing a control spring on a new sash or old sash removed from the frame, nail a spring to each edge of the sash so that the top of the spring is 6 inches below the top rail of the upper sash, or 6 inches below the check rail or lower sash. Use two 16-gage, ¼-inch-long brads for each spring. When installing the spring on an inplace sash, raise the lower sash at the high point and hold the spring with prongs toward the frame. Push the spring up between sash and frame, using enough pressure to flatten the top

spring curve to permit it to slide upward. Install the spring on the opposite side of the sash in the same manner. Lower the upper sash to the low point and follow the same installation instructions as above, except push the spring downward. No nails or screws are required.

7.2.2.7 *Balancing Adjustment.* When a sash with spiral or pullman-type balances is out of balance, follow the manufacturer's directions for balance adjustment. Attempts to repair such sashs without compliance with prescribed directions may result in further damage.

7.2.3. Metal Windows

Maintenance and repair of metal windows is usually considerably less than that for wood. General repair is similar to that for metal doors. Rusting, warping, and sticking of operating devices are the most common failures. It is important to lubricate mechanisms regularly and to keep fastening devices secure. Problems of alignment caused by building settlement must be adjusted in conjunction with overall corrective measures, which may involve stabilizing the foundation and framing. Caulking must be maintained in good order to prevent leakage of moisture and air.

7.2.4 Vinyl Windows

Vinyl windows have frames and lineal components of solid PVC or PVCclad wood or aluminum or other combinations of PVC and metals. These windows can have low coefficients of heat transmission and air infiltration which give them an ad-vantage over some other types of windows; however, they can be more expensive and their selection must be based on lifecycle cost analysis similar to that described in appendix C for vinyl siding. Vinyl windows are low maintenance by comparison to wood types. The vinyl used is resistant to cracks, peeling, blisters or other surface defects. Painting is unnecessary for vinyl; however, vinyl clad wood may require painting to the interior surface.

7.2.5 Venetian Blinds

Venetian blinds, when permitted by criteria, should conform to Federal Specification AA-V-00200B. Head boxes, usually installed between the reveals of jambs, should be set level on brackets designed to allow convenient removal and replacement without damage to the blinds or adjacent surfaces. Brackets should be secured in place with screws, nails, or other fasteners. Replacement of worn tapes and cords is the major maintenance problem with venetian blinds. A check for broken or bent slats should be made when cords or tapes are replaced, since slats can only be replaced by removal of the cords.

7.2.6 Caulking and Sealing

7.2.6.1 *General.* Caulking and sealing compounds are used to seal and waterproof exposed joints around wood and metal frames that are built into exterior concrete and brick, stone, concrete block, glass block, and other masonry. This includes control joints in masonry construction. Caulking compounds are used in wood construction for sealing joints around door and window frames. See figure 7-6. Factors which influence joint design and choice of joint sealant are briefly discussed so that these principles may be applied with understanding to the maintenance program.

7.2.6.2 *Joint Designs.* In movable joints, the elements to consider in the design are their spacing, sizes, and shapes. Since the ability to expand and contract varies a great deal with different sealants, the percentage of expansion required generally determines the sealant to be used. It is therefore necessary to calculate the anticipated expansion and contraction of the joint due to temperature changes. The coefficients of thermal expansion of the building material to be sealed, and the spread between the winter low and summer high temperatures will be used in the design and shape of movement. The type of sealant can be selected, based on service conditions and movement. The maximum strain that a particular sealant can endure can be determined in the laboratory by testing to failure at different temperatures. Reputable manufacturers will supply dependable data. The maximum working elongation in movable joints will be 10 percent for caulking compounds and a single-component elastomer, and 25 percent for rubber-base sealants. For example, a joint is calculated to move ¼ inch in width during the period between the high and low inservice temperatures. Using the maximum working elongation of 25 percent for rubber-base sealants, the joints would be 1 inch wide. Then following the rule of thumb that the joint sealant should be onehalf the width of the joint in depth, the joint would be 1 inch wide by ½ inch deep.

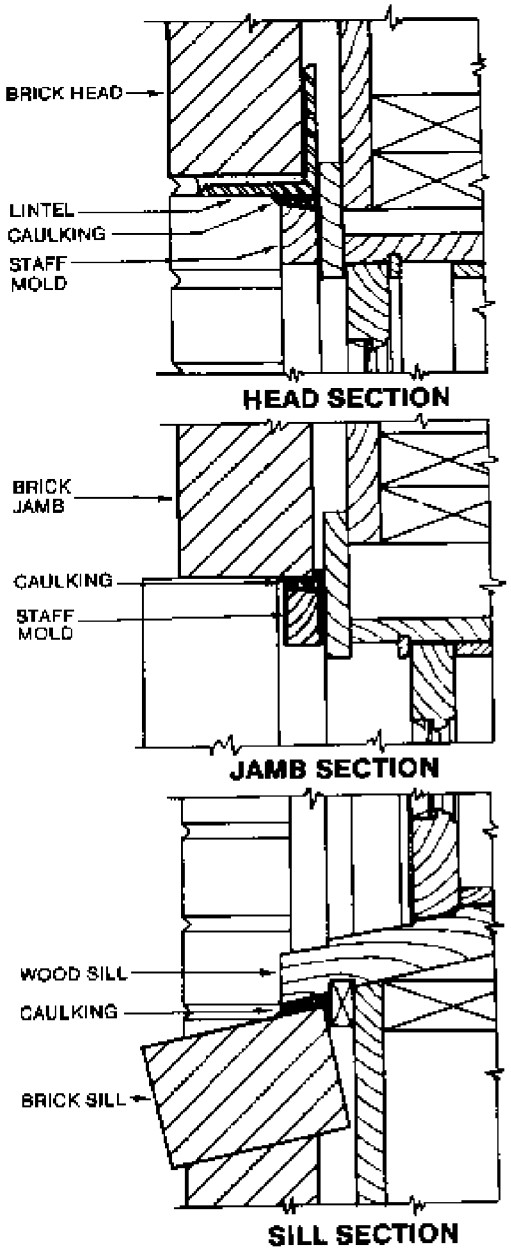


Figure 7-6. REQUIRED CAULKING AROUND WOOD WINDOW FRAME.

7.2.6.3 *Sealing Aid and Techniques.*

a. Appearance. Well-designed joints have a good exterior appearance, provide economical maintenance, and assure weathertight joints.

b. Backup. Backup material is used to control depth of sealant in a deep joint cavity. This material should be flexible enough to allow the sealant to assume the shape in compression or tension as indicated in figure 7-7.

A nonmoisture-absorbing backup material should be used. Of the resilient materials, the extruded closed-cell flexible foams and sponge rubber will be used for expansion and control joints. Tubes or beads of polychloroprene or butyl may also be used.

c. Primer. A primer is required on the sealant contact surfaces of porous construction materials. Depending on weather conditions, primers will dry in approximately 1 hour; coverage will average

about 200 square feet per gallon, depending on porosity of the material to be primed.

d. Cleaning Solvents. Solvents will not be allowed to air dry without wiping. Perchloroethylene is used for removing waxes from surfaces to be sealed. VMP-naphthlene is used for cleaning in acrylic glazing and for edges of shatterproof glass. Recommended solvents from glass manufacturers also should be considered. Use a mixture of equal parts of xylene and acetone or toluene or methyl ethyl ketone for cleaning the glazing surfaces of aluminum curtain-wall sashes. Ammonium bifluoride or muriatic acid may be used to clean masonry surfaces receiving the sealant. After the surfaces are cleaned, neutralize the muriatic acid with a dilute solution of household ammonia, wash the joint cavity with clean water, and allow to dry.

e. Joint Accessibility. Where practical, a joint should be designed to be accessible for inspection and repair. When a joint becomes inaccessible after construction has been completed, the sealant should be a more permanent type considered than that which would be used for the accessible joint.

f. Tip Size. Select the proper tip size for the gun so that the sealant will extrude and fill the joint cavity in one pass.

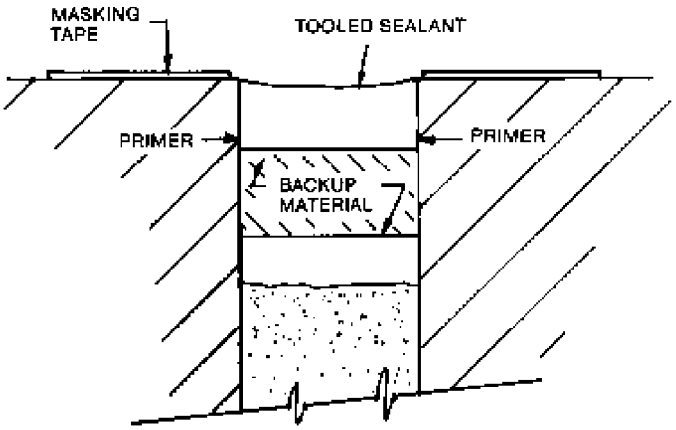


Figure 7-7. RAKED MORTAR JOINT CAVITY.

g. Tooling. Tooling the sealant forces the sealant into the joint cavity, insures good surface contact, and finishes off the exterior surface of the joint. Tooling white or light-colored sealants should be done with a dry or water-wet tool only. Solvents, detergents, or soapy solutions frequently used by applicators to allow the tool to slip freely, may discolor sealant surfaces.

h. Masking. Masking either or both surface edges of the joint cavity provides a straight line to the joint, protects wall surfaces from smears, and allows sealant to overlap slightly on the wall, providing a better surface seal. Application is suggested prior to priming, especially on light-colored masonry or other porous surfaces. Most primers discolor somewhat with age or weather exposure. Staining is easily noticeable in areas at ground level, entrance ways, steps, etc. Fresh sealing compound smears can be removed from masonry by scraping smears off immediately and rubbing clean with methyl ethyl ketone, acetone, or a similar solvent.

7.2.6.4. *Surface Preparation.*

a. Steel Surfaces of Movable Joints. The surfaces in the joint cavity to be in contact with the sealant will be cleaned of all permanent or temporary protective coatings before the sealant is applied.

b. Steel Surfaces to Tight or Nonmovable Joints. The sealant may be applied over the permanent coating. Temporary protective coatings will be removed to bare metal before applying the sealant.

c. Aluminum Surface of Movable or Nonmovable Joints. The aluminum surfaces in contact with selants will be cleaned of the temporary protective coating. Solvents, when used for cleaning, will be as recommended by the applicators of the coating, and the solvent will be the nonstaining type. Lintless paper towels should be used for wiping off the solvent cleaner and coating. The use of rags tends to be too long,

which results in the surfaces not being well cleaned or wiped of. Masking tape is also used for temporary protective cover on the area to be in contact with the sealant. This tape should be removed just prior to the application of the sealant.

d. Contact Surfaces of Joint Cavities. Joint cavity contact surfaces that have come in contact with mold-release agents, curing compounds, silicon water repellents, floor hardeners, and other surface treatments will require prior cleaning preparation before sealants are installed. Wire brushing, sandblasting, masonry saw cutting, or other similar preparation may be required to clean the joint cavity in wood, concrete or masonry construction.

7.2.6.5. *Sealants.* The following general requirements and intended uses will be considered in selecting sealants. When colors are required, they should be those standard with the supplier. For unusual conditions, the purchaser and the supplier should agree on an acceptable color when cured. Painting over a cured sealant is permissible, but the supplier should again be consulted. The paint material should have some flexibility when covering movable joints.

a. Basic Types. The basic types of joint sealants are the so-called caulking compounds, the one- and two-component rubber-base sealants, the one-part elastomeric sealants (also tapes and beads), and preformed gaskets. Each type is manufactured in several different materials. No one material or joint design will satisfy all conditions for a good sealant installation. Each type of sealant has its limitations. Combinations of sealants make some of the most effective seals. Poor joint design, use of inappropriate sealants, and poor workmanship in preparing surfaces and applying the sealants will cause failure of the joints and sealants.

b. Bulk-Type Compounds. Broadly classified, sealing and caulking materials are the bulk type, supplied in cartridges, cans, or drums and applied either by gun or knife, or the preformed types, supplied in extruded shapes, tapes and beads.

(1) The principal ingredients of oil- and resin-base caulking compound are vegetable, hydrocarbon or drying oil, and resins mixed with asbestos fibers and other inert ingredients. It is ready-mixed for immediate use and can be applied under ordinary building conditions, 40° to 100° F (4.5° to 37.8° C). It is for use in wood or metal fixed joints and in very limited movable joints. It has a short life expectancy unless used where it will be regularly painted, coated, or have other protective coverings.

(2) Two-component types that are rubber base and chemical curing are liquid polysulfide polymers and polyurethane polymers. The ambient temperature at the time of application will be 40° to 80° F (4.5° to 26.7° C), and the inservice temperature will be-60° to 200°(-51.1° to 93.3° C). They require accurately controlled premixing and careful application and cure to a rubbery material with high adhesion. Their intended uses includes expansion and movable joints in concrete, masonry, and metal; perimeter sealing of metal frames in exterior walls; curtain-wall construction as joint sealer, and beading and settling of glass and panels. The self-leveling type is used for joints in horizontal surfaces, and the nonsag type for joints in vertical surfaces.

(3) Single-component types that are rubber base and chemical-curing include sulfides, silicones, and polyurethanes. The ambient temperature at the time of application will be between 50° and 100° (10° to 37.8° C), except that the silicone type will be between 0° and 120° F (-17.8° to 8.9° C). The inservice temperatures will be from -20° to 200°F (-28.9° to 93.3° C), except that the silicone type will be from-80° to 350° F (-62.2° to 176.6° C). The sealants are premixed and ready for immediate application. They require careful handling and storage and have a relatively long curing time. They are intended for use in locations similar to those for the two-component compounds although the curing times, application temperatures, and other factors will dictate which compound will best serve the joint.

(4) Nonskinning compounds, which are polybutenes or blends of polybutenes and polyisobutylenes (butyl) mixed with asbestos fibers or other inert ingredients, are ready-mixed for immediate use. Ambient temperature at time of application will be from 0° to 10° F. Inservice temperature range will be from-60° to 200° F. The material is nondrying and the exposed surfaces are tacky. It is to be used in fixed and unmovable joints between metals or glass, as bedding compounds, in interior joints in protected locations, and in glazing metal curtain-wall construction. This type of sealant may be used below grade.

7.2.7. Glazing

7.2.7.1 *General.* Glazing repair consists of sash reconditioning and replacement of broken glass. Maintenance often involves only replacement of loose, deteriorated, or missing putty. Glazing items in buildings and structures generally should be replaced using the same type of materials used in -the original work. The quality of replacement materials should be improved only when justified by obvious inadequacy of the failed materials, and when

planned future use of the buildings or structure warrants it. Consideration may be given to providing double-pane insulating window glass where it can be economically justified. It should be noted that glass size is sometimes specified by the so-called "united inches method," which is the sum of the length and width of the size specified, i.e., one-half the perimeter. Example: Glass size of 12 inches wide by 15 inches long would be specified as 27 united inches.

7.2.7.2 *Flat Glass.* Flat glass used for glazing sash, doors, and other uses will conform to requirements of current Federal Specification DD-G-1403.

a. Clear Window Glass. Clear window glass, Type II, Class 1, Quality 96, is recommended for replacements in hospitals, administration buildings, and other similar structures. The use of Quality 96 in quarters and service buildings will afford a savings in material costs. The following schedule may be used as a guide for thickness and size of installed clear window glass: Single- strength glass should be used in sheets 400 square inches to 7 square feet in area; above that limit, glass $^{3}/_{16}$ inch thick should be used where plate glass is not required.

b. Polished Plate or Float Glass. Polished, clear-vision plate or float glass is used around prominent entrances, in large openings, for air deflectors, shelving, bulletin board doors, and projection booth observation ports. Polished plate glass should be Type 1, Class 1, Quality 96, and have a nominal thickness of ¼ inch.

c. Wire Glass. There are two kinds of wire glass, Type III, Class 1: A (flat) and B (corrugated). Flat wire glass, usually ¼ inch thick, is used in doors, windows, fixed sidewall sashes, and some sky-lights. Corrugated wire glass, $^{5}/_{16}$ inch or more thick, is used mostly in skylights. Clear, flat wire glass, polished on two sides, is used in windows and doors of detention, storage, and other buildings where security and clear vision are necessary.

d. Obscured Glass. Figured glass, Type III, Class 1, Kind A, Form 3, Quality 911, Finish Fl, not less than **c** inch thick, is used where clear vision is not necessary or is undesirable. Such locations would include windows and doors in toilets, baths, dressing rooms, operating rooms, surgical dressing rooms, shops, garages, and warehouses. Figured or ribbed glass, smooth on one side, is desirable for use in doors and windows of buildings such as shops, garages, and warehouses where clear vision is not required.

e. Heat-Absorbing Glass. Heat-absorbing glass, Type 1, Class 2, Style A (or Style B), is installed in the sash of control towers and other spaces where occupants are exposed to direct or reflected rays of the sun. This glass is generally ¼ inch thick, clear, ground, and polished. Its solar-heat-reflecting and luminous-transmittance qualities are described in current Federal Specification DD-G-1403. Where clear vision is not required, the rolled figured, blue-green, obscure glass should be used.

f. Light-Diffusing Glass. Figured glass, Type I, Kind A, Form 5, Quality 911, Finish F2, is usually not less than ¼ inch thick. The surface design may be a series of cylindrically shaped lenses on each side of the glass, with the lenses on one side running at right angles to the other. An alternate design is a series of parallel rows of circular lenses one each side, with the centers of the lenses on one side halfway between centers of the lenses on the opposite side. Depending on the manufacturer's standards, circular lenses may be spaced ¼ or ½ inch on centers. This lens-type glass is especially desirable for use in borrowed-light partitions and in spaces where an even distribution of light in all parts of the room is necessary.

g. Colored Glass. Sheet glass, Type II, Class I, Quality 95, is acceptable for use in the exterior sashes of chapels. It is a hammered or figured-pattern sheet not less than **c** inch thick. Generally, it is amber in color. Several other colors are available.

h. Shatterproof Glass. Shatterproof glass is installed to advantage in observation windows in engine-test rooms, detention rooms, and other places requiring a high resistance to breakage. Glass may be tempered or laminated, not less than ¼ inch thick, and polished on both sides. Tempered glass is made by reheating the glass until it is somewhat soft, and then cooling it quickly in a bath of oil or against a metallic surface. It withstands heavy impacts and great pressures, but a comparatively light blow with a pointed object on or near the edge may break it because of internal stresses resulting from sudden cooling. This type of glass may fly apart violently when broken. Laminated glass gives protection against flying pieces of broken glass. The glass is built up in the manner of a sandwich, with a sheet of transparent adhesive bond between two sheets of glass. If a break occurs, the plastic stretches, serves as a cushion, and holds the sharp fragments.

i. Insulating Glass. Double-pane and triple-pane insulating glass, each of the same nominal thickness, is separated by not less than $^{3}/_{16}$-inch dehydrated airspace and hermetically sealed at the factory, Dehydration should be guaranteed for a period of not less than 10 years. Glazing techniques

for insulating glass may be found in paragraph 7.2.7.10.

7.2.7.3 *Putty.* Putty for wood-sash glazing must conform to current Federal Specification TT-P-00791. Types I and II may be used interchangeably, but Type II is recommended for filling holes and cracks where a harder material is desirable. Putty and compound for metal-sash glazing must conform to current Federal Specification TT-G-410. Types I and II are both suitable for interior and exterior work. Type I is an elastic glazing compound that dries on the surface but remains slightly soft and plastic underneath. It is recommended for use, in addition to wood or metal beads, on doors, transoms, and skylights, where repeated shock or vibration may be encountered. Oil or other adulterants should not be added to putty or compound on the job. Putty or glazing compound should be stocked in relatively small quantities so that it will be fresh when used. A 30-day supply is suggested as sufficient for ordinary installation needs. One gallon of putty or compound will normally bed and face glaze approximately 100 linear feet of ¾-inch rabbet, 150 linear feet of ½-inch rabbet, or 200 linear feet of **d**-inch rabbet.

7.2.7.4 *Glazier's Points and Clips.* Glazier's points for wood-sash glazing should be standard zinc triangles of approximately ½-inch equilateral. Wire slips for metal windows vary by type of window. A reserve supply for maintenance work should be available at all times.

7.2.7.5 *Paint*

a. General. Painting is mentioned here only to serve as a reminder that it must be accomplished prior to glazing or reglazing. The selection and application of paints and other protective coatings are covered in detail in a separate Tri-Services manual, "Paints and Protective Coatings" (TM 5-618, NAVFAC MO-110, AFM 85-3).

b. Wood-Sash Primer. Good maintenance and repair practice requires that wood-sash glass rabbets be primed or sealed before the glass is set. Shellac and quick-drying varnish should not be used as primers because they dry to hard glazed surfaces that may prevent a tight putty bond.

c. Wood-Sash Finish Paint. Surfaces of jambs, stop beads, and sashes in sliding contact may be finished with penetrating sealer in lieu of paint.

d. Metal Sash. Metal should be cleaned and primed before glazing or reglazing is done. Red lead-base, ready-mixed paint is suitable for touch-up or complete priming.

7.2.7.6 *Glasscutting.* Insofar as possible, glass should be purchased and stocked in sizes that can be used without cutting. Glass of special sizes is cut in the shop. For glass sizes, measure all four sides of the sash and deduct $^{1}/_{16}$ to **c** inch in the pane size for irregularities in the sash. Minimum equipment required for glasscutting consists of a table, a common wood or metal T-square, and a glasscutter. The table should be about 4 feet square with front and left edges square. Mark off the surface of the table vertically and horizontally in inches. A thin coating of turpentine or kerosene on the glass line to be cut is helpful in lubricating the action of the cutter wheel. A sharp cutter must be carefully drawn only once along the line of the desired cut. Additional strokes of the cutter may result in breakage. Allow about 5 percent for breakage in cutting and setting. When extensive cutting is anticipated, a commercially manufactured cutting board is available that incorporates the above-mentioned minimal equipment plus a spring-loaded grip for the glasscutter that slides along the bar, assuring good, clean glasscutting. This board is used in a vertical position and occupies very little floor space.

7.2.7.7 *Preparation Before Glazing.*

a. Old Wood Sashes. Clean all putty runs of broken glass fragments and glazier's points. Remove loose paint and putty by scraping. Wipe the surface clean with cloth saturated in mineral spirits or turpentine, prime the putty runs, and allow them to dry.

b. New Wood Sashes. Remove dust, prime the putty runs, and allow them to dry. All new wood sashes shall be pressure-treated for decay protection (see Tri-Services manual, "Military Entomology Operations Handbook," Chapter 8, Section 5, NAVFAC MO-310, TM 5-632, AFM 91-16).

c. Old Metal Sash. Remove loose paint or putty by scraping. Use steel wool or sandpaper to remove rust. Clean the surfaces thoroughly with a cloth saturated in mineral spirits or turpentine. Prime bare metal and allow it to dry thoroughly.

d. New Metal Sash. Thoroughly clean the sash with a cloth saturated in mineral spirits or turpentine to remove dust, dirt, oil, or grease. Remove rust with steel wool or sandpaper. If the sash is not already factory-primed, prime it with rust-inhibitive paint and allow it to dry thoroughly.

7.2.7.8 *Setting Glass.* Do not glaze or reglaze exterior sash when the ambient temperature is 40° F (4.5° C) or lower unless absolutely necessary. Sash and door members must be thoroughly cleaned of dust with a brush or cloth dampened with turpentine or mineral spirits. Lay a continuous $^{1}/_{16}$ inch thick bed of putty or compound in the putty run. See figure 7-8. The glazed face can be

recognized as the side on which the glass was cut. If the glass has a bowed surface, it must be set with the concave side in. Wire glass is set with the twist vertical. Press the glass firmly into place so that the bed putty will fill all irregularities.

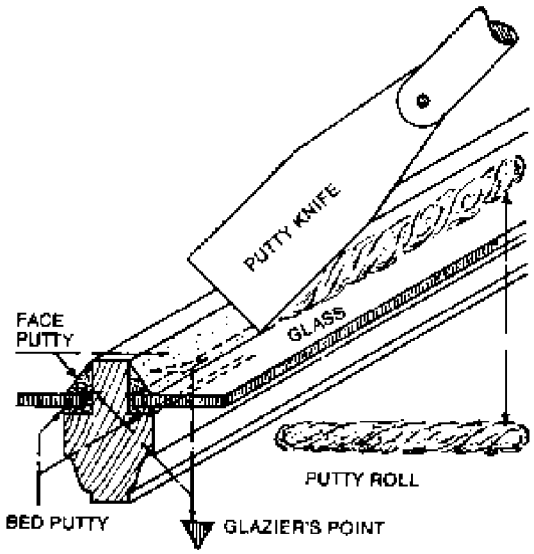


Figure 7-8. SETTING GLASS WITH GLAZIER POINTS AND PUTTY.

a. Glazier's Points. When glazing wood sash, insert two glazier's points per side for small lights and about 8 inches apart on all sides for large lights. When glazing metal sash, reuse the wire clips or metal glazing beads. See figure 7-9.

b. Putty. After the glass has been bedded, lay a continuous bead of putty against the perimeter of the glass-face putty run. Press the putty with a putty knife or glazing tool with sufficient pressure to insure its complete adhesion to the glass and sash. Finish with full, smooth, accurately formed bevels with clean-cut miters. Trim up the bed putty on the reverse side of the glass. When glazing or reglazing interior sash and transoms, whether fixed or movable, and interior doors, use wood or metal glazing beads. Exterior doors and hinged transoms should have glass secured in place with inside wood or metal glazing beads bedded in putty. When setting wire glass for security purposes, set wood or metal glazing beads, secured with screws, on the side facing the area to be protected. Wood sash putty should be painted as soon as it has surface-hardened. Do not wait longer than 2 months after glazing. Metal sash, Type I, elastic compound, should be painted immediately after a firm skin forms on the surface. Depending on weather conditions, the time for skinning over may be 2 to 10 days. Type II, metal sash putty, can usually be painted within 2 weeks after placing. This putty should not be painted before it has hardened because early painting may retard the set. The paint should completely cover the putty and extend approximately **c** inch onto the glass surface to serve as a seal.

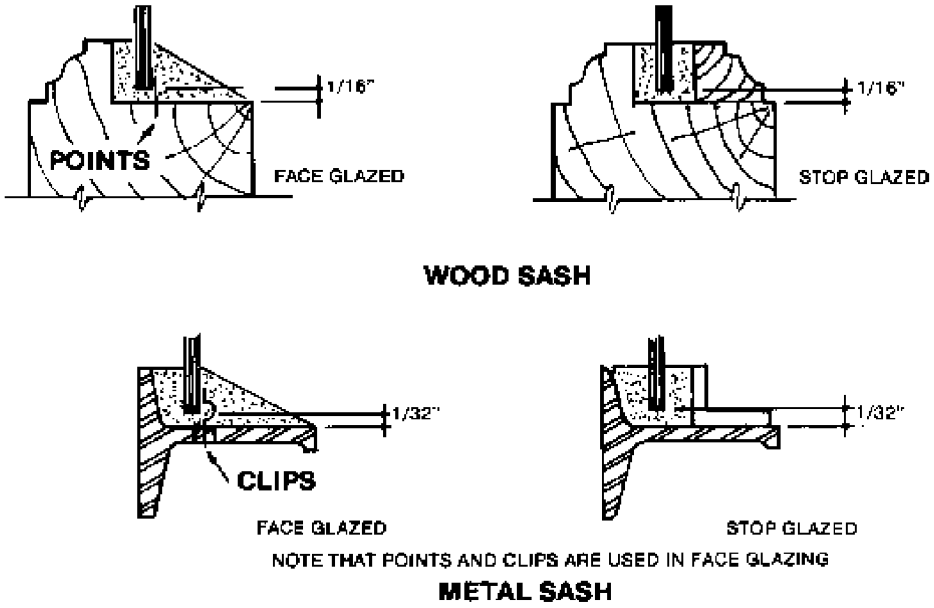


Figure 7-9. WINDOW GLAZING.

7.2.7.9 *Cleaning.* Clean the glass on both sides after painting. A cloth moistened with mineral spirits will remove putty stains. Ammonia, acid solutions, or water containing caustic soaps must not be used. When scrapers are used, care should be exercised to avoid breaking the paint seal at the putty edge.

7.2.7.10 *Insulating Glass.* Two major types of insulating glass are currently manufactured which are designed to improve the U-value of the glass unit. These are double- and triple-pane units with hermetically sealed airspaces separating the panes. The panes are separated by a dessicated spacer, which absorbs moisture from the airspace, and are permanently sealed.

a. Preparation of sashes and frames should follow the same procedures outlined in paragraph 7.2.7.7. The sash must be of sufficient width to accommodate the size unit to be installed. Sufficient allowance must include a glazing leg minimum of ¾ inch.

b. Two setting blocks spaced at the quarter points should be of neoprene or lead construction with manufacturer's recommended hardness and length.

c. Unit must be installed square.

d. A weep system should be incorporated into any insulating glass installation to drain excess moisture away from the unit. Weep holes should be a minimum **d**-inch thickness and installed three per unit.

e. Glazing methods are illustrated in figure 7-10. The tape method utilizes a high-quality rubber material suitable for specific installations with a release paper on one side. The tape is fitted to the

opening with corners butted, not overlapped, joints sealed, and the paper removed just prior to installation. Constant pressure is maintained against the tape from proper stop design. The tape and wet seal method utilizes the same procedure as the tape method except that a **c**-inch clearance is allowed between the top of the tape and the top of the stop which is filled with an elastomeric sealant of polysulfides, silicones, urethanes or acrylics. The edge of the sealant should be leveled to improve weatherproofing. The wet glazing method requires the use of space shims on the face of the stops at intervals of 18 inches on center maximum. The sealant is forced into the existing space using a caulking gun or power equipment. Putty and glazing compounds should not be used with insulating glass. Several structural glazing gaskets are also available for installing insulating glass as shown in figure 7-10.

f. Glazing systems which apply pressure to the edge of glass for waterproofing should be maintained at a pressure of 4 to 10 pounds per linear inch of perimeter or as recommended by the manufacturer. Avoid pressure on the marginal edge (**c**-inch) of the unit.

7.2.7.11 *Safety Requirements.* Handling and cutting glass creates a serious cutting hazard. Appropriate gloves and other personal protective equipment must be provided. Adequate procedures for the disposal of cuttings and broken glass should be established.

7.2.8 Window Screens.

Included in this category are half-length sliding window screens, full-length window screens, and fixed porch screens.

7.2.8.1 *Screen Cloth.* Mesh screening in current use is made of comparatively short-lived steel or iron wire, either painted or galvanized. Continued use of such painted or galvanized screen cloth is not recommended for other than planned, short-use buildings. Do not use steel or iron wire screening in tropical zones. The use of corrosion-resistant material, such as copper, bronze, aluminum or plastic, is recommended for most screening needs. Bronze wire is recommended for installation in barracks, dining facilities, and similar buildings where rough usage may be expected. Commercial bronze, better known as brass, is not recommended for use in areas subject to excessive condensation and salt air. Shipments of screening delivered on requisitions for bronze should be tested to see that brass has not been substituted.

7.2.8.2 *Wire and Mesh Sizes.* The diameter of metal or plastic strands and the size of the openings are important. Screen cloth having mesh openings no larger than 0.0475 inch is recommended for all installations. Screen cloth suitable for most locations is the 18 x 18 mesh per inch made with 0.011-inch-diameter strands. Screen cloth recommended for tropical areas is type with the 0.015-inch-diameter strands, with opening sizes no greater than 0.0475 inch.

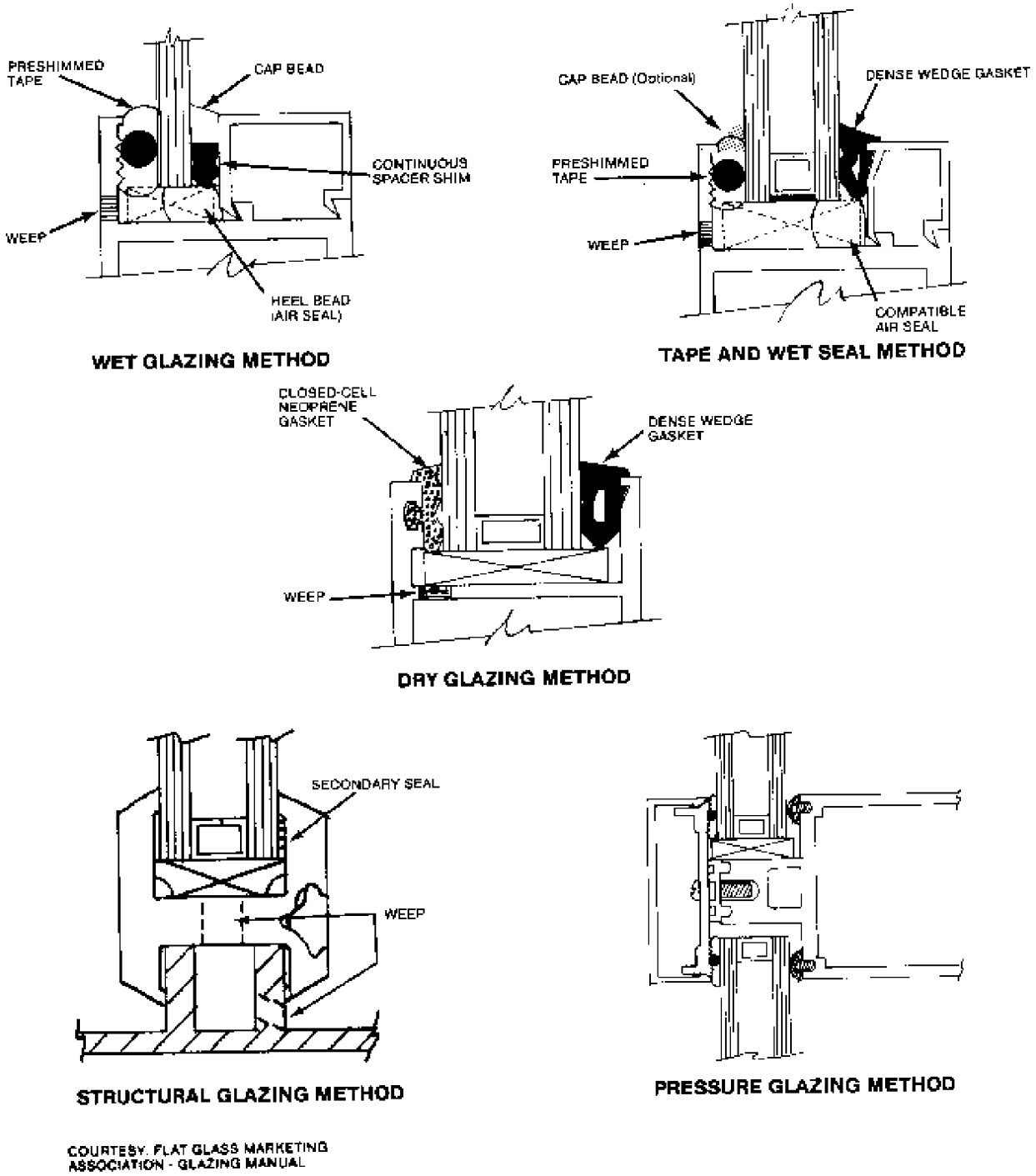


Figure 7-10. INSULATED GLASS GLAZING TECHNIQUES.

7.2.8.3 *Replacing Broken Screen Cloth.* A too large, free screen area is one of the causes of early screen failure. A screen area between supports will be no more than 2 x 3 feet, if possible. Window screens eventually require repair of screen cloth, refastening of screening, or repainting. When screen is broken and replacement is necessary, cut a piece of screen cloth large enough to permit tacking to frame. Tack new screening along one end completely, holding it tight as tacking

proceeds. Then tack opposite end, pulling wire from end to end, as well as along the side which is being tacked. Finally, tack along other two sides which should require practically no pulling. Do not pull mesh out of shape, and keep strands parallel to sides of frame. Then replace molding which, when fastened down firmly, takes up any remaining slack in the wire. Prompt repair of tear will often preclude replacing entire screen. To repair a screen, cut a piece of screen cloth slightly larger than the torn opening. Bring the edges of the tear back to their original position as nearly as possible, and cover with the patch piece. Sew edges of patch to existing screen with fine wire or monofilament fishline.

7.2.8.4 *Screen Protection.* Push-bars and hardware cloth guards are screen savers, especially where traffic is heavy. Fasten wood or metal push-bars approximately 45 inches above the floor. Hardware cloth guards extend from lock rail to bottom rail and may be either ½-inch-square mesh, 19-gage steel wire of 1-inch, diamond mesh woven from 16-gage steel wire. Guards should be given black finish. They should be set close against the screen and firmly secured at all edges.

7.2.8.5 *Screen Storage.* Removable window screens should be taken down in the fall and stored in a dry place during the winter months. Do not store screens on a concrete floor or on the ground. Inspect screen frames and screen cloth before placing them in storage. Make necessary repairs and paint frames. Patch or replace damaged screen cloth. If signs of rust or corrosion are detected, brush clean and apply a protective coating.

SECTION III—BUILDERS' HARDWARE

7.3.1 Metals and Finishes

7.3.1. *General.* The composition of materials in builders' hardware is of fundamental interest. It often affects the ability of the product to maintain appearance and durability and can have an important bearing on the worth of a product under a particular circumstance. Except for the few instances where plastics, woods, and ceramics are used, builders' hardware is made of metal. Selection of the base metal and finish depends on such factors as use, exposure to elements, and appearance desired. Also, hardware in a room should harmonize in design and finish. In this discussion "base metal," which is the material out of which the basic portions of the hardware item are manufactured, is differentiated from "finish," which denotes the surface characteristics of the product. The finish may be simply the result of treatment of the basic metal, or it may be achieved by the addition of a second metal or other product.

7.3.1.2 *Base Materials.* Basic metals used in builders' hardware are brass, bronze, iron, steel, stainless steel, aluminum, and zinc. Competition between producers of the various metals, which may be cast, extruded, forged, or wrought, is frequently keen, especially with changes in production capacity and technology. Although not metal, plastics are being used in a manner similar to a base metal in manufactured hardware products.

a. Cast Metal. Cast metal is produced by pouring molten alloy into premolded forms. This method results in a versatile shape which can be machined, etched, or carved to yield a great variety of designs. It is very durable, withstands considerable abuse, and will take a fine finish in brass and bronze. However, castings are costly to produce and thicknesses are not as uniform as forging and extensions.

b. Extrudes. Extruded shapes are produced by forcing or drawing semimolten metal through dies, like a chef uses a pastry bag. Designs having linear characteristics are possible. Extrusions are very durable but limited in application due to restrictions of cross sections that can be designed or formed. Generally, extrusions are limited to brass and aluminum.

c. Forged Metal. Forged metal is hammered, pressed, or rolled into shape. A smooth, dense product results from this process, the value of which relates to the thickness of the metal. Forged metal has considerable tensile strength due to the uniform denseness of the metal. It has excellent finishing and machining capabilities. Many items that were formerly cast are now forged. Material with thickness greater than 0.080 inch is acceptable in lieu of cast material.

d. Wrought Metal. Wrought metal is rolled into flat sheets or stripes. The products are formed by punching or diecutting into the desired forms. It may be thick, as in a hinge, or thin, as in a push-plate.

e. Brass and Bronze. Brass and bronze are metal alloys, the greatest portion of which are copper and those containing smaller amounts of other metals, notably lead and zinc. Bronze differs from brass in that it contains some tin. Differences in color result from the proportions of the various metals included. Cast brass has a yellowish color, while cast bronze has a reddish hue.

f. Steel. Steel is widely used in builders' hardware. It is stronger than iron. Ordinary carbon steel contains not only iron but portions of other elements such as carbon, manganese, phosphorus, and sulfur. Exposed to the weather, carbon steel is likely to rust. Its wide use results largely from its strength and lower cost. Most of the builders' hardware items made of wrought steel are formed in flat sheets by dies in heavy presses.

g. Stainless Steel. Stainless steel is an iron product of which there are about 40 standard types. Each contains substantial amounts of chromium and small quantities of a number of other elements. A majority of types also contain appreciable percentages of nickel. Because it is highly rust-resistant, has a higher luster finish, and is easily maintained, stainless steel is prized as a builders' hardware material. The popularity of this metal has increased; most manufacturers now provide a large range of stainless-steel products, such as locks, trim, door-closure arms, butt hinges, kick plates, push- and pull-plates. It is very desirable when extreme, rugged use is expected.

h. Aluminum. Aluminum is now in many ways in builders' hardware. It is usually alloyed with about 4 percent of other elements. Cast, forged, and wrought products are obtained by much the same processes as are other metals. Pressure-cast aluminum is frequently used as a substitute for cast iron in miscellaneous items, such as door-stops, handrail brackets, and hooks.

i. Powdered Metal. Powdered metal is pressed into shape and then sintered in a furnace. For additional strength, it may be sintered again. The process is employed to form a range of products from various metals..

j. Cast Iron. Cast iron's characteristics are its long-wearing qualities, natural lubrication, brittleness, low tensile strength, and tendency to rust. Cast iron contains 92 percent iron and small quantities of such other elements as carbon, manganese, silicon, phosphorus, and sulfur. The metal is poured into sand molds to achieve the desired shape.

k. Malleable Iron. Malleable iron is cast iron treated by baking or annealing to make it tough and shock-resistant. When properly cast and annealed, malleable iron can be bent and even knotted without breaking. Many manufacturers use malleable iron in items like pulls and closure arms to reduce the possibility of breakage and provide resistance to stress.

l. Forged Iron. Forged iron's greatest use in builders' hardware is in the manufacture of specialized or decorative trim often imitative of early-American, hand-forged items. Iron forgings are produced by hammering a red-hot bar of iron into the desired shape. Forged iron is almost pure iron, with only about 1 percent of other elements.

m. Zinc. Zinc has long been used in builders' hardware as a coating over iron and steel, since it resists rust. Many products are made using die-cast zinc as a base metal. It is easily cast, machined, and plated.

n. Plastics. The rapid advance of plastic technology has led to the development of durable and serviceable materials such as Bakelite, nylon, delrin, lexan, lucite, and formica. Although plastics are becoming more widely used, they have many shortcomings and are not as acceptable as metal. However, plastics have been successfully used for kick plates, mop plates, door-edging lock mechanisms, knobs, pulls, and hand levers.

7.3.1.3 *Finishes.* Natural finishes take the color of the base metal in the product and may be either high or low luster. Applied finishes result from the addition by plating of a second metal, a synthetic enamel, or other material.

a. Finishes. Finishes for builders' hardware have undergone tremendous changes in recent years. New techniques and finishes have been introduced, changes in popularity have taken place, and some finishes have been dropped. The preparation given base materials prior to finishing consists generally of machining, buffing, and polishing. Polished brass and bronze finishes are produced by buffing or polishing the metal to a high gloss before applying a synthetic coating. Satin brass and bronze natural finishes are obtained by dry-buffing or scouring, and the resultant finish is then coated. Uncoated finishes of brass or bronze are used where natural oxidation of the entire exposed surface yields the desired result. Oil rubbing of uncoated bronze produces a dark oxidized finish suitable for some decors. The chromiums, polished and satin, are brass, bronze and nickel plating of builders' hardware has been done for scores of years, usually by means of an electrolytic process. Oxidizing is also used, especially where the designs are ornamental.

b. Coatings. Coatings are used to prevent tarnishing or oxidation of plated brass and bronze finishes. The original color and sheen of natural metals can be maintained for a long time with the use of modern, synthetic coating treatments.

c. Anodizing. Anodizing forms a protective and uniform oxide on aluminum, giving it a hard, tough skin. A variety of color anodized finishes, such as black and oxidized bronze, are available.

d. Finish Standards. Although the National Institute of Science and Technology, U.S. Department of Commerce, some years ago prepared product standards for the finishes used with builders' hardware, the Door and Hardware Institute (DHI) has updated the standards, consistent with current practices in the industry. DHI Standard 1301, Finish Standards, lists 96 standard finishes and their nearest U.S. equivalents. Samples of selected standard finishes may now be obtained from DHI.

7.3.2 Hands of Doors

The dictionary lists no less than 91 connotations of the word "hand." This well demonstrates the specialized language of builders' hardware and the need to understand the language. In the builders' hardware industry the position of the hinges on a door, in terms of right or left, as viewed from the outside of a building, room, or space to which the doorway leads, determines the hand. The hand of a door is a term used to indicate the direction of the swing of the door. See figure 7-11. The outside is the side from which security is necessary. In a series of connecting rooms (as in a hotel suite) the outside will be the side of each successive door approached from the entrance. For two rooms of equal importance with a passage between, the outside is the passage side. Strictly speaking, the door itself is only right or left hand; the locks and the latches may be reverse bevel. However, it is necessary to include the term reverse and to specify in accordance with the conventions shown here. This will prevent any confusion as to which side is the outside. This is especially important when different finishes are desired on the opposite sides of the door. Although the hardware items specified may be reversible, or even universal, it is good practice to identify the hand completely, in accordance with the convention here stated. For a person standing outside, the rule is that an inswinging door is regular bevel and an outswinging door is reverse bevel. Hardware in general may be:

7.3.2.1 *Universal.* Used in any position (e.g., a surface bolt).

7.3.2.2 *Reversible.* Hand can be changed by revolving from left to right, or by turning upside down or by reversing some part of the mechanism (e.g., many types of locks and latches).

7.3.3 Hinges

7.3.3.1 *General.* There are four basic applications of hinges: full mortise, half mortise, full surface, and half surface. See figure 7-12. Within each type there are various styles, each designed for a particular situation. In addition to these there are other design types, such as olive knuckle, modern paumelle and pivots. Hinges are further classified by such characteristics as mounting or movement control. A butt hinge is a type designed for mortising into the butt edge of the door and into the rabbet of a door frame. A spring hinge contains one or more springs to move the door into a closed position. See figure 7-13. It may be either single or double acting. A checking floor hinge is a device which combines top and bottom points for hanging the door with a controlled-speed closing mechanism. Top, intermediate, and floor pivots make possible installations to solve special design problems and to enable transfer of weight from the jamb to the floor.

7.3.3.2 *Elements of Hinges.* Swaging is a slight offset of the hinge at the barrel, which permits the leaves to come closer together and improves the operation and appearance of the door. A leaf is one of the two attaching plates, which, when fastened together by the hinge pin, form a complete hinge. Bearings (ball, oil-impregnated, or antifriction) offer the highest qualities in ease of operation and durability. Nonrising pins are a feature of quality hinges. Close tolerances, especially in the pin, prevent excessive wear, and are an important characteristic of high-quality, heavy-duty hinges. Hinges are available in brass, bronze, stainless steel, and carbon steel.

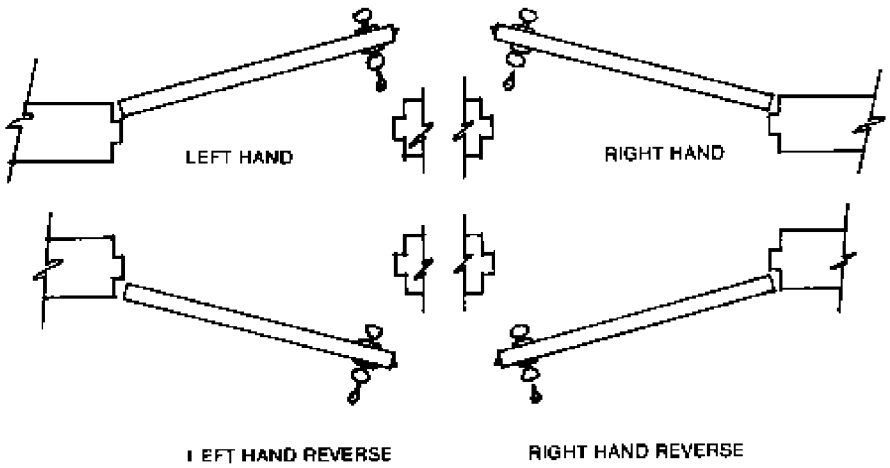
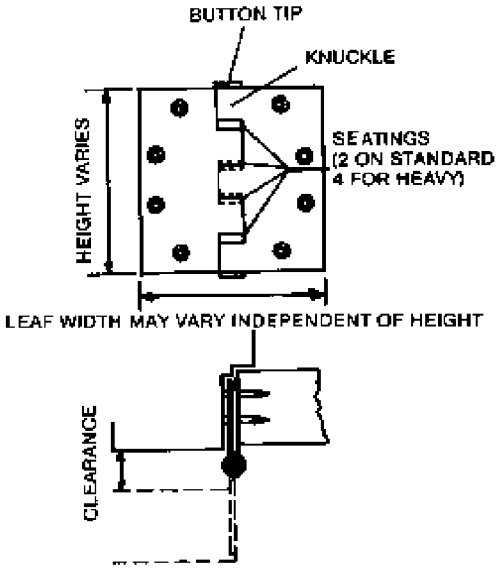
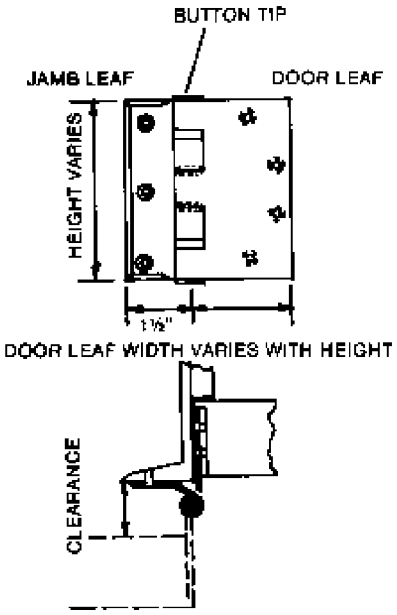


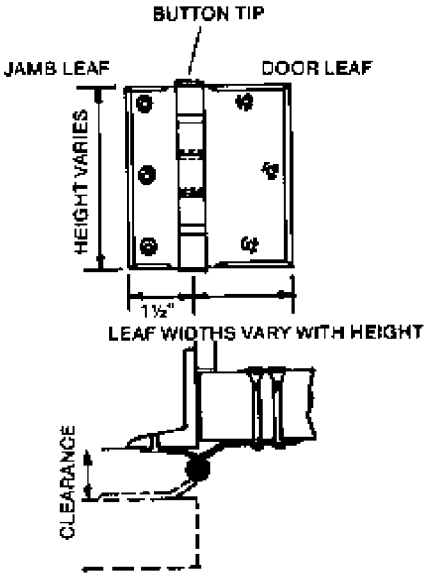
Figure 7-11. HANDS OF DOORS.



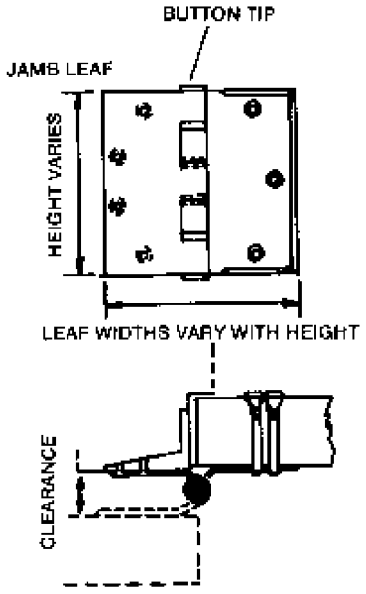
FULL MORTISE



HALF MORTISE



FULL SURFACE



HALF SURFACE

Figure 7-13. HINGE TYPES.

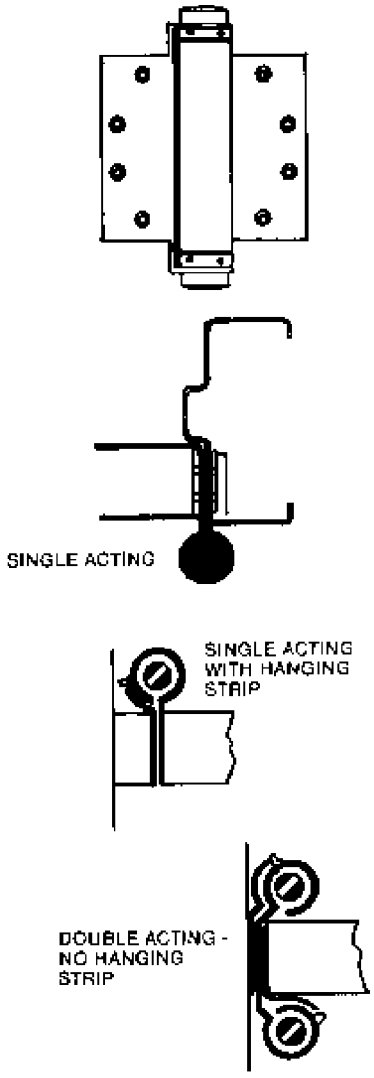


Figure 7-13. SPRING HINGES.

7.3.3.3 *How to Specify Hinges.* Hinges are specified by number (in pairs); either ball, oil-impregnated, or antifriction bearings; type of tips; type of screws; type of hinge; metal; height-width (required only for full mortise hinges); weight (standard or heavy); and finish. The number of hinges per door varies with the height of the door. Generally, a minimum of three per door is recommended, but two may suffice for doors to 5 feet high. Three are required for doors up to 7 feet 6 inches high. One additional hinge is required for every additional 30 inches. Template hinges are made to standard templates (in accordance with Government standards) to insure exact matching of hinges and their screw holes with doors and jambs, either metal or wood, made by other manufacturers.

7.3.3.4 *Screws and Fastenings.* It is the custom to supply as regular packing all machine screws and wood screws or combination screws which can be used with both wood or metal. Through-bolts and grommet nuts, where so indicated, are furnished regularly for application of half-surface or full-surface door leaf, along with machine screws for jamb.

7.3.3.5 *Size and Gage.* It is important that the size of the hinge and the gage of metal are adequate for the job and are consistent with the size, weight, and frequency of use of the door. In sizing hinges, the

first dimension is that taken at the leaf. This is the vertical height of the hinge, which is the first numeral on full-mortise hinges, not including the tip. Table 7-1 provides a helpful tabulation for determining size and gage.

TABLE 7-1. — HINGE GUIDE

Door		*Minimum Hinge Height (in)*
Thickness (in)	*Width (in)*	
f or 1	Any	2½.
1 **c**	To 36	3.
1 **d**	To 36	3½.
1 **d**	>36	4.
1¾	To 41	4½
1¾	> 41	4½ Heavy.
1¾ to 2¼	Any	5 Heavy.

Use proper width of hinge if trim clearance is required. Hinges should be heavy weight for heavy doors or doors of high frequency and unusual stress. Heavy-weight hinges should have a minimum width of 4½ inches when used for doors 1¾ inches thick. On all exterior doors opening out and reverse bevel interior doors with locks, a pin which cannot be removed when the door is closed or an interlocking leaf feature should be specified. Ball, oil-impregnated, or antifriction bearing hinges should always be specified for doors equipped with door closures.

7.3.4. Locks

7.3.4.1. *General.* One of the most important categories of builders' hardware is locks. The names used for locks were originally selected to identify either the type of construction or installation. Considering the great variety of functions, types, sizes, weights, security and convenience features of locks, considerable experience is fully required to select the proper lock for a particular use. The locks most commonly used in all types of construction are described below. See figure 7-14.

7.3.4.2. *Bored Type.* These types of locks are installed in a door having two round holes at right angles to one another, one through the face of the door to hold the lock body and the other in the edge of the door to receive the latch mechanism. When these two are joined together in the door, they comprise a complete latching or locking mechanism. Bored-type locks have the keyway (cylinder) and locking device, such as push or turn buttons, in the knobs. They are made in three weights-heavy, standard, and light duty. The assembly must be tight on the door, without excessive play. Knobs should be held securely in place without screws and a locked knob should be removable. Roses should be threaded or secured firmly to the body mechanism. The trim has important effects in this type of lock, because working parts fit directly into the trim. Regular back-set for a bored lock is usually 2¾, but it may vary.

7.3.4.3. *Preassembled Type.* The preassembled-type lock is installed in a rectangular notch cut into the door edge. This lock is one that has all the parts assembled as a unit at the factory, and when installed little or no disassembly is required. Preassembled-type locks have the keyway (cylinder) in the knobs. Locking devices may be in the knob or on the rose or excutcheon. Regular backset is 2¾ inches. The lock in available only is heavy-duty weight.

7.3.4.4. *Mortise type.* A mortise lock is installed in a prepared recess (mortise) in a door. The working mechanism is contained in a rectangular-shaped case with appropriate holes into which the required components, cylinder, knob and turn-piece spindles are inserted to complete the working assembly. Regular backset is 2¾ inches. These locks are available in heavy-duty and standard-duty weight. Armored fronts are available. In order to provide a complete working unit, mortise locks, except for those with deadlock function only, must be installed with knobs, levers, and items of trim.

7.3.4.5. *Integral Type.* An integral lock is a mortise lock with a cylinder in the knob. It is installed in a prepared recess (mortise) in a door. A complete working unit consists of the lock mechanism and selected trim (knob, rose, escutcheon). Roses or escutcheons are bolted together through the lock case. Regular backset is 2¾ inches. This type is available only in heavy-duty weight.

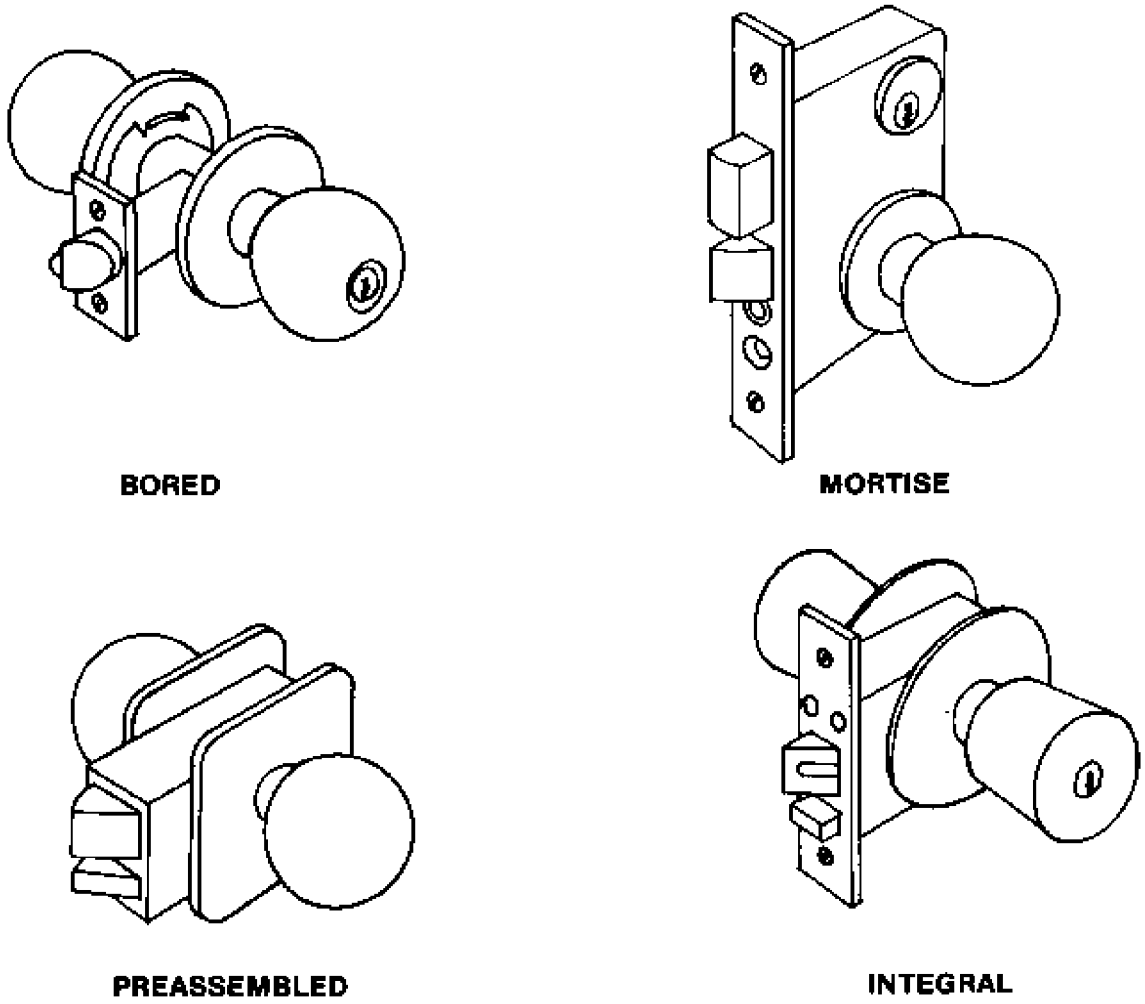


Figure 7-14. LOCK TYPES

7.3.4.6 *Details.*

a. Bolts. The lock achieves its function by means of various types of bolts. The bolt is a bar of metal, which projects out of the lock into a strike prepared to receive it.

b. Latchbolts. The function of a latchbolt is to hold the door in a closed position. A latchbolt is spring actuated and is used in all swinging-door locks except those providing dead-bolt function only. It has a beveled face and may be operated by a knob, handle or turn. It is recommended for the

heavy-duty bored, mortise, preassembled, and integral types that some kind of antifriction provision be incorporated. The throw of the latchbolt must not be less than ½ inch. "Throw means the projection of the latchbolt beyond the lock face. Friction occurs when a latchbolt hits the lip of the strike. An antifriction feature is recommended to insure easy closing of the door. This is particularly desirable when door-closing devices are used. This device may be a split latchbolt, a plastic insert in the bolt or in the strike, a pivoted bolt, or a self-lubricating bolt.

c. Auxiliary Deadlatch. An auxiliary deadlatch is a security feature and should be required on all locks used for security purposes, unless a dead-bolt function is specified. This feature deadlocks the latchbolt automatically and makes it virtually impossible to depress the latchbolt when the door is closed.

d. Dead bolt. A dead bolt is a bolt having no spring action and is activated by a key or by a turn. It must be manually operated. Dead bolts provide security. When hardened steel inserts are used, the security is greater. The minimum throw should be ½ inch. A dead bolt may be specified with certain functions or mortise, preassembled, and integral locks.

e. Lock Strikes. A lock strike is a metal plate mortised into the doorjamb to receive and to hold the projected latchbolt. It is sometimes called a "keeper." The proper length lip should be specified so that the latchbolt will not hit the doorjamb before the strike. A wrought box should be installed back of the strike in the jam. This box will protect the boltholes from the intrusion of plaster construction debris or other foreign material, which would prevent the bolt from projecting properly into the strike. Standards covering installation dimensions for locks have been issued by the American National Standards Institute. These include dimensions for strikes, the use of which provides uniformity in frame preparation.

f. Electric Strike. This is an electromechanical device which replaces an ordinary strike and makes possible remote electric locking and unlocking of a door. A control mechanism actuates the electric strike and allows the door to be opened and relocked without a key. Optional features available include accommodation for dead bolt, automatic unlocking if power fails, and built-in provision to indicate the door is not locked. There are various designs of electric strikes for use with numerous types of locks and exit devices.

g. Cylinders. The cylinder of a lock is the cylindrical-shaped assembly containing a tumbler mechanism and the keyway, which can be actuated only by the correct keys. For servicing, such as keying, all cylinders may be removed. In some types it is also possible to remove the keyway assembly but only by means of a control key. To provide greater security, special cylinder collars are available.

SECTION IV—MAINTENANCE AND REPAIR OF HARDWARE

7.4.1 Bolts and Screws

All bolt and screw heads should be carefully inspected, and any that show rust discoloration or rust scale should be thoroughly wire-brushed. If any bolts or screws have corroded to the extent that they lack good fastening strength, they should be removed and replaced. When the holes where bolts or screws are removed are too large for new fasteners, new holes should be drilled and new fasteners of the drive-screw or self-tapping type provided in an adjoining solid portion of the metal.

7.4.2 Door and Window Hardware

Interior and exterior hinged, sliding, and rolling doors of every type, including storm and screen doors, should be checked for faulty installation and lack of maintenance. The operation and condition of hinges, lock assemblies, closers, tracks, hangers, and other hardware items should be checked. If parts are rusted, they should be cleaned and a light coat of oil applied. The same procedure applies to the mechanical operator for monitor sash and skylights. Available keys should be fitted for proper lock operation. Brass and bronze surface plates and knobs should be cleaned as described in paragraph 7.4.11.

7.4.3 Door-Closing Devices

The first thing to check on any closing device is proper installation according to the manufacturer's instruction sheet. Often closers are applied too near or too far from the hinge jamb, which affects operation as well as shortening the life of the closer. It is imperative that the closer and its arm be in their correct places and firmly fastened. Familiarization with the adjustment features of the devices to be maintained is necessary for a proper understanding of their functions. The manufacturer's instruction sheet should be valuable for this. Closing devices that have hydraulic controlling action, such as liquid door closers and checking

floor hinges, must be refilled with the correct type of fluid at regular intervals. Keeping closers full of liquid is one way to prolong their lives as well as insure smooth operation. Finally, all closing devices should be overhauled periodically, which involves complete disassembly and cleaning in the shop. Floor-type closers for exterior doors in locations subject to ice and snow are usually difficult to maintain and should always be installed on the inside of outswinging doors. To simplify maintenance, concealed-type door closers should be limited to locations where they are necessary for operational reasons.

7.4.4 Locksets

The basic function of a lockset is to lock or latch a door in its closed position; therefore, the first order of maintenance should be to determine whether the lock is in alignment with its strike. The latch-bolt should set easily into the strike without any binding or scraping. The dead bolt, when projected by action of key or turn, should also seat without cutting away wood or other material behind the strike. In the operation of knobs, set screws must be tight. Before tightening, however, the knob action should be tested to see if it is free. If not, the setscrews should be loosened in the shank and knob turned counterclockwise, just enough to permit easy action without binding. Then the set-screws should be retightened. Make sure they bear against a flat side of the spindle rather than on a corner. If the knobs have "screwless" or "clutch" fastenings, a spanner wrench will be needed to make adjustments. The wrench should be used to loosen the inside knob shank, and this knob or its shank component threaded up or down the spindle, depending on the adjustment necessary. The lubricating agent for locks and cylinders is dry graphite. Do *not* use grease or oil. To free gummed or corroded parts, kerosene or penetrating oil may be used, but this should be allowed to evaporate before reassembly. Bored or unit types of locksets represent a somewhat different problem in that they have knobs and roses assembled in an integral part of the lock mechanism. Adjustment features differ greatly among the various makes; therefore, it is recommended that the manufacturer's instructions be consulted before any attempt is made to correct poor installations.

7.4.5 Thresholds

Loose fastenings are often a source of trouble with thresholds. At each inspection, screws should be tightened, and loose anchors and expansion shields replaced. Check for dirt and gravel, particularly in interlocking types. The door strip should be set in the interlock. Replacement thresholds should always be placed in new caulking bases.

7.4.6 Sliding-Door Equipment

The various types of hangers have both vertical and lateral adjustment. Find how these work and consult the manufacturer's specifications to attain the utmost efficiency in keeping the doors sliding easily. Bottom tracks and guide channels should be kept free of debris.

7.4.7 Panic-Exit Devices

Particular care must be taken to insure proper operation of exit devices. Under no circumstances should bars, chains, padlocks, or auxiliary locks be used on exit doors. Familiarization with these devices will enable personnel to keep them functioning to lock against ingress while still permitting unimpeded egress. This involves keeping strikes aligned and free of debris so that latches will hold. Crossbars that are loose or flabby in action indicate that service is needed. Check for worn springs, pivots, or spindles. When astragals are present, they should be adjusted to keep center clearance at a minimum. See discussion of fire doors, paragraph 7.1.6.

7.4.8 Security Fences and Gates

To maintain stability and to correct alignment, connections for gates, posts, braces, guys, and anchor on security fences should be tightened. Hinges, latches, locking devices, and other hardware should be cleaned and lubricated for easy operation.

7.4.9 Skylights

Skylights made of multiple supporting members and panes are often a source of leaks. As a rule, maintenance consists only of replacing sealing strips, cushion strips, and skylight compound at joints between glass sheets. When glass, metal flashings, and joint cappings must be replaced, materials and methods should be similar to those used in the original installation. Wood or steel structural frame members that have deteriorated should be replaced.

7.4.10 Vents

Metal vents should be inspected for deterioration caused by lack of protective paint or inadequate paint coverage. Vents should not be exposed to standing water. They should be equipped with a flashing flange to prevent early flashing failure because of expansion and contraction of the vents. For metal flashing, roof-drainage devices, gravel

stops and edge strips, see Tri-Services manual, "Maintenance and Repair of Roofs," (TM 5-617, NAVFAC MO-113. AFP 91-31, MCO P11014.9).

7.4.11 Cleaning and Maintenance of Aluminum

7.4.11.1 For routine cleaning of aluminum, the mildest method will usually work easily and well. However, conditions vary, and if the surfaces have been neglected for a long time, it may be necessary to experiment with small areas before selecting a method. Three methods of routine cleaning are:

a. Wash with clean water and dry thoroughly. Wash with a synthetic detergent cleaner, rinse, and dry. Use a nonetching chemical cleaner according to the cleaner manufacturer's directions.

b. If the aluminum has accumulated a thick coating of dirt, it is usually easier to remove the heavy dirt with a solvent cleaner. Then try one of the following operations: a wax-base polish cleaner with a clean, soft rag or pad, following the manufacturer's directions; a nonwax-base polish cleaner with a clean, soft rag or pad, following manufacturer's directions; or a mild abrasive cleaner (scouring powder) on a damp, clean cloth. Rinse well and dry after any of these operations.

c. If the results of methods (a) and (1)) are unsatisfactory, use a stainless-steel wool pad of fine texture with a liquid wax or one of the cleaners mentioned under method (b). Mild steel wool can also be used; however, any remaining particles will rust-stain the aluminum and should be removed.

7.4.11.2 In the process of waxing aluminum, the aluminum should be cleaned thoroughly with a solvent cleaner. The wax should be applied with a soft, clean cloth; polishing should be done with another soft cloth. Before lacquering an aluminum surface, old lacquer that is worn off in spots should be stripped completely with a lacquer remover. The surface should be cleaned with a solvent-type cleaner. For good lacquer adhesion, it is preferred that a good "tooth" on the surface be attained by using an etching type of cleaner. After 3 to 5 minutes, the surface should be rinsed with clean water, and then a thorough wet coat of lacquer applied by paint spray equipment, if available. Otherwise, a clean paintbrush should be used, and the lacquer thinned as the manufacturer recommends. The first coat should be allowed to dry, and then a second coat applies in the same manner. To protect aluminum from stains and other damage, the use of strong cleaners should be avoided and the aluminum padded against scraping or denting by heavy loads.

7.4.12 Brass and Bronze Finishes

Natural brass and bronze finishes age quite well and contribute to the beauty of a building. No attention to this hardware is required other than wiping it with a damp cloth until the original lacquer begins to wear off. When abrasion of the lacquer becomes apparent, the best appearance will be achieved by use of a lacquer thinner or some nonacid agent to remove all remaining lacquer coating. Then the piece may be polished with brass polish. In time, the latter will impart an attractive, soft luster, characteristic of old brasses and bronzes.

7.4.13 Miscellaneous

There are many types of builders' hardware items not specifically mentioned in this manual. All of them must be examined periodically if they are to function properly. Tight fastenings and proper lubrication will keep most of them working. The applicable hardware manufacturer's instructions for assembly and parts should be available for the proper maintenance of hardware items.